

Chemical Engineering Master's Defense

Analysis of Chlorination & UV effects on microplastics
using Raman spectroscopy

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abstract

Microplastics are emerging to be major problem when it comes to water pollution and it poses a great threat to the marine life. These materials have the potential to affect a wide range of human population since we are major consumers of the marine life. Microplastics are less than 5 mm in diameter, and can escape from traditional wastewater treatment plant (WWTP) processes and end up in our water sources. Due to their small size, they have a large surface area and can react with chlorine, which it encounters in final stages of WWTP. After the microplastics accumulate in various bodies of water, they are exposed to sunlight, which contains oxidative UV light. Since the microplastics are exposed to oxidants during and after the treatment, there is strong chance that it will undergo some sort of structural change. The WWTP conditions were replicated in the lab by varying the concentrations of chlorine from 70 to 100 mg/L in increments of 10 mg/L and incubating the samples in chlorine baths for 1–9 days. The chlorinated samples were tested for any structural changes using Raman spectroscopy. High density polyethylene (HDPE), polystyrene (PS), and polypropylene (PP) were treated in chlorine baths and observed for Raman intensity variations, Raman peak shifts, and the formation of new peaks over different exposure times. HDPE responded with a lot of oxidation peaks and shifts of peaks after just one day. By varying the concentration, the rate of intensity decrease for select backbone peaks was studied. For the degradation of semi-crystalline polymers, there is a reduction in crystallinity and, hence, to verify that thermal analysis was performed. There was a decrease in the enthalpy of melting and melting temperature with an increase in the exposure time and chlorine concentration, which pointed at the degradation of plastics and bond cleavages. To test the plastic response to UV, the samples were exposed to sunlight for up to xx days and analyzed under Raman spectroscopy. Overall, all the tests done on three microplastics mentioned resulted in degradation of plastics.

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